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New Records of *Polyphlebium borbonicum*, an African Filmy Fern, in the New World and Polynesia

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ABSTRACT.—*Polyphlebium borbonicum* is newly recorded in Central and South America and Easternmost Polynesia (Marquesas and Society Islands). It has been misidentified as *P. diaphanum* and as *P. endlicherianum* in the New World and in the Pacific, respectively. *Polyphlebium borbonicum* is distinguishable from true *P. diaphanum* by broader blade segments, and from true *P. endlicherianum* by the absence of a marginal elongate cell row of the lamina.

KEY WORDS.—distribution, Hymenophyllaceae, Marquesas

In the course of preparing a treatment of Hymenophyllaceae for the *Vascular Flora of the Marquesas Islands* project, it came to our attention that specimens identified as *Trichomanes endlicherianum* C. Presl (= *Polyphlebium endlicherianum* (C. Presl) Ebihara & K. Iwats.) comprise two quite different forms. The first form has lanceolate fronds with an obvious row of clear elongate cells along the margins (Figs. 1a, 2d), and resembles typical *P. endlicherianum* distributed in the South Pacific. The second form has larger and broader fronds, an ovate outline, and no clear marginal cell row (Figs. 1b, 2a). So far, no species matching the characters of the second form has been recorded in the South Pacific area. From a global viewpoint, this form best matches *Polyphlebium borbonicum* (Bosch) Ebihara & Dubuisson, an African species. *Polyphlebium borbonicum* was originally described based on a specimen from Bourbon Island (La Réunion) and is widely distributed in tropical Africa (Beentje, 2008; Kornaś, 1994), but has not been recorded in either the New World or in Polynesia (with the exception of a single occurrence of *P. borbonicum* recently noted by Nitta (2008) in Moorea, French Polynesia; this specimen has been included in the current analysis).

We also noticed that some New World plants usually identified as *Trichomanes diaphanum* Kunth resemble both *P. borbonicum* and the

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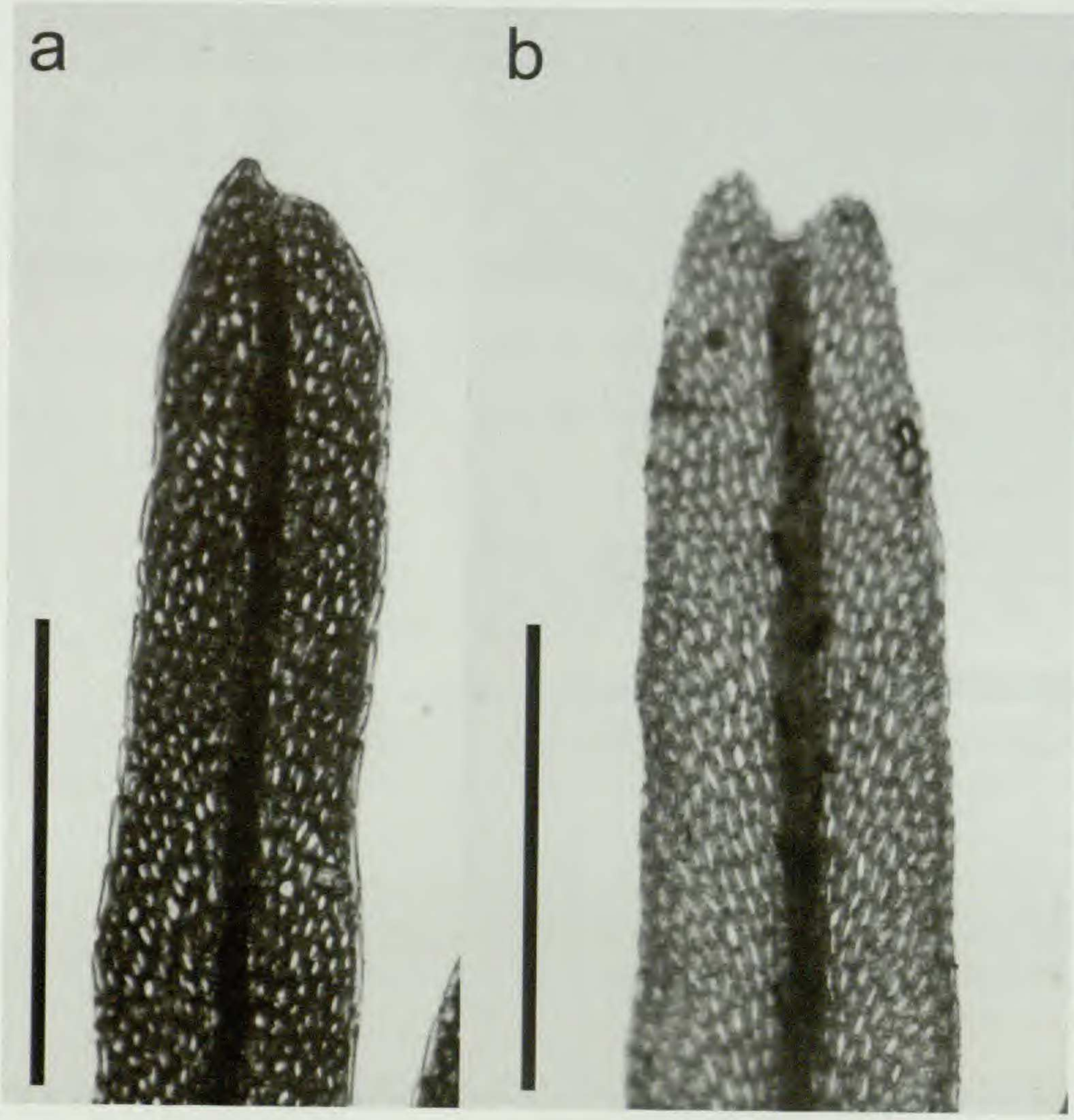

FIG. 1. Laminar cells of two Marquesas species. a. *Polyphlebium endlicherianum* (D. Lorence 9127, PTBG) with transparent marginal elongate cells; b. *P. borbonicum* (K. R. Wood 10500, PTBG) without marginal elongate cells. Scale: 1 mm.

unidentified Polynesian plant. Examination of 1077 base pairs (bp) of chloroplast *rbcL* sequences (methods of DNA and phylogenetic analyses followed Ebihara *et al.*, 2005), suggests that *P. borbonicum* of Réunion is the species most closely related to Polynesian *P. endlicherianum*. All samples examined in this study (Table 1) form a robustly supported monophyletic clade together with *P. borbonicum* of Réunion (Fig. 3). Based on both morphological and genetic homologies, we treat these disjunct distributed plants as a single species, *Polyphlebium borbonicum*.

The genus *Polyphlebium* as redefined by Ebihara *et al.* (2006) is comprised of about 15 species, located mainly in the southern hemisphere, with no species widely distributed across multiple continents. Since *P. borbonicum* has been misidentified as *P. endlicherianum* in Polynesia, and was submerged under the wider morphological variation of the *P. diaphanum* – *P. hymenophylloides* complex in the New World (Table 2), with proper

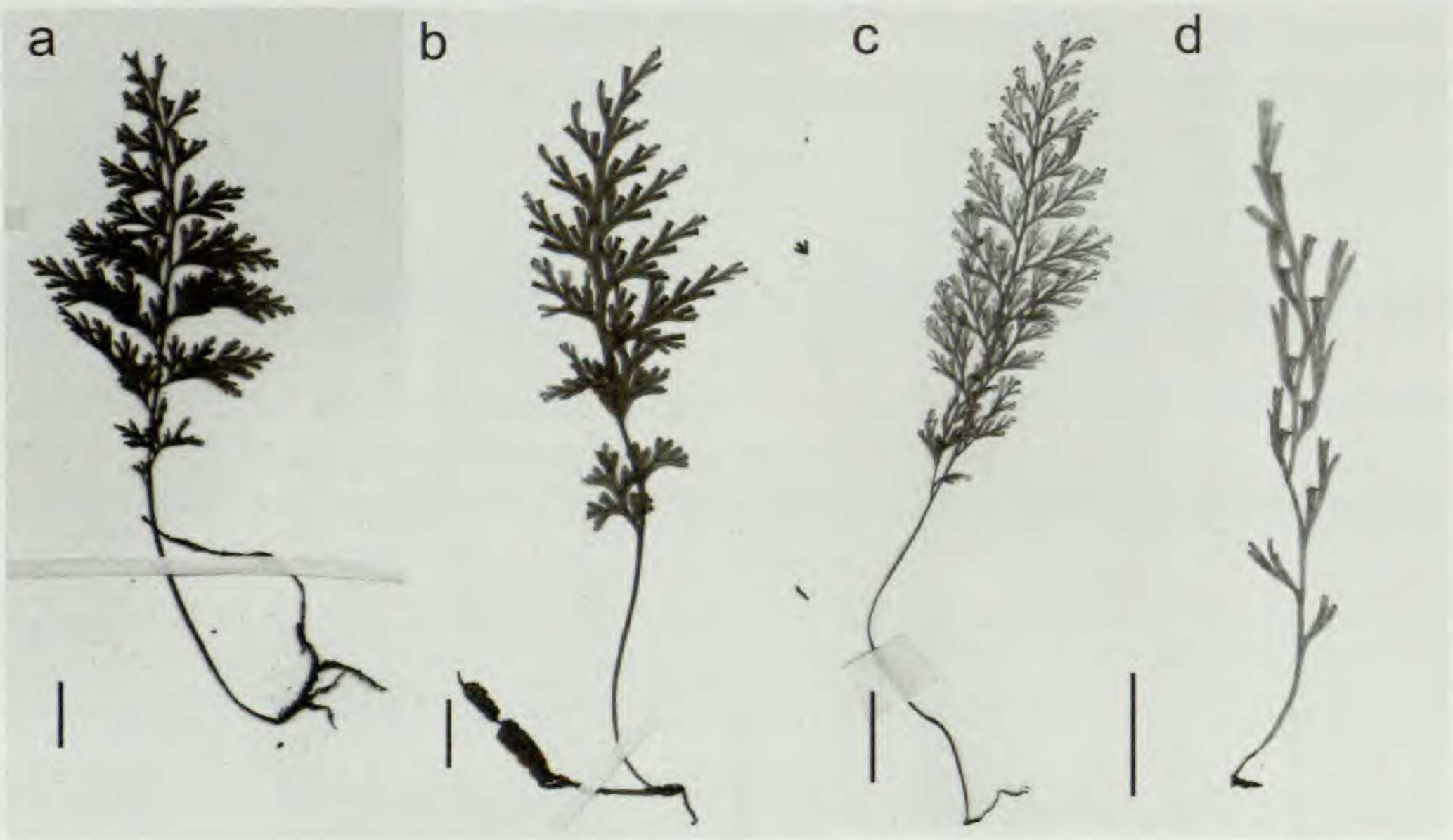

FIG 2. a–c. Specimens of *Polyphlebium borbonicum*. a. Marquesas Islands (K. R. Wood 4522, PTBG 24332); b. Bolivia (M. Kessler et al. 11435, UC 1621639); c. Réunion (J.Y. Dubuisson HR1999-22, P); d. a specimen of *P. endlicherianum* from the Marquesas Islands (D. Lorence 9127, PTBG). Scale: 1 cm.

identification, we propose that *P. borbonicum* is widely distributed across the paleotropics and neotropics (Fig. 4).

Polyphlebium borbonicum of the New World is recognizable by its segments of unequal length and broader fronds (more than 3 cm wide) in most cases. *Trichomanes debile* Bosch, a name long overlooked and synonymized under *P. diaphanum* (e.g., Lellinger 1989), has recently been applied by A. R. Smith to specimens having flat wings and less developed pinnae (pinnules at the basiscopic side are usually unbranched) at an acute angle against the rachis (identification was made for the herbarium specimens of UC) (Fig. 1b). Our result (Fig. 3) showed that one of two samples of *T. debile* is nested in the clade of *P. borbonicum* and that the other is closely related to the clade. We here advocate a taxonomic treatment synonymizing *T. debile* under *P. borbonicum*.

TABLE 1. Samples of *Polyphlebium borbonicum* used for phylogenetic analysis. [1]Sequences newly obtained for this study.

Original identification	Locality	Accession	Voucher (Herbarium)
P. borbonicum	Réunion	AY175782	Dubuisson HR1999-2 (P)
"*P. endlicherianum*"	Society Islands, Moorea	EU122988	Nitta 073 (UC)
"*P. endlicherianum*"	Marquesas Islands, Ua Huka	AB445233[1]	Wood 10501 (PTBG)
"*T. debile*"	Bolivia, Prov. Sud Yungas	EU784118[1]	Kromer 1753 (UC)
"*T. debile*"	Bolivia, Prov. Ayopaya	EU784117[1]	Jimenez 1568 (UC)

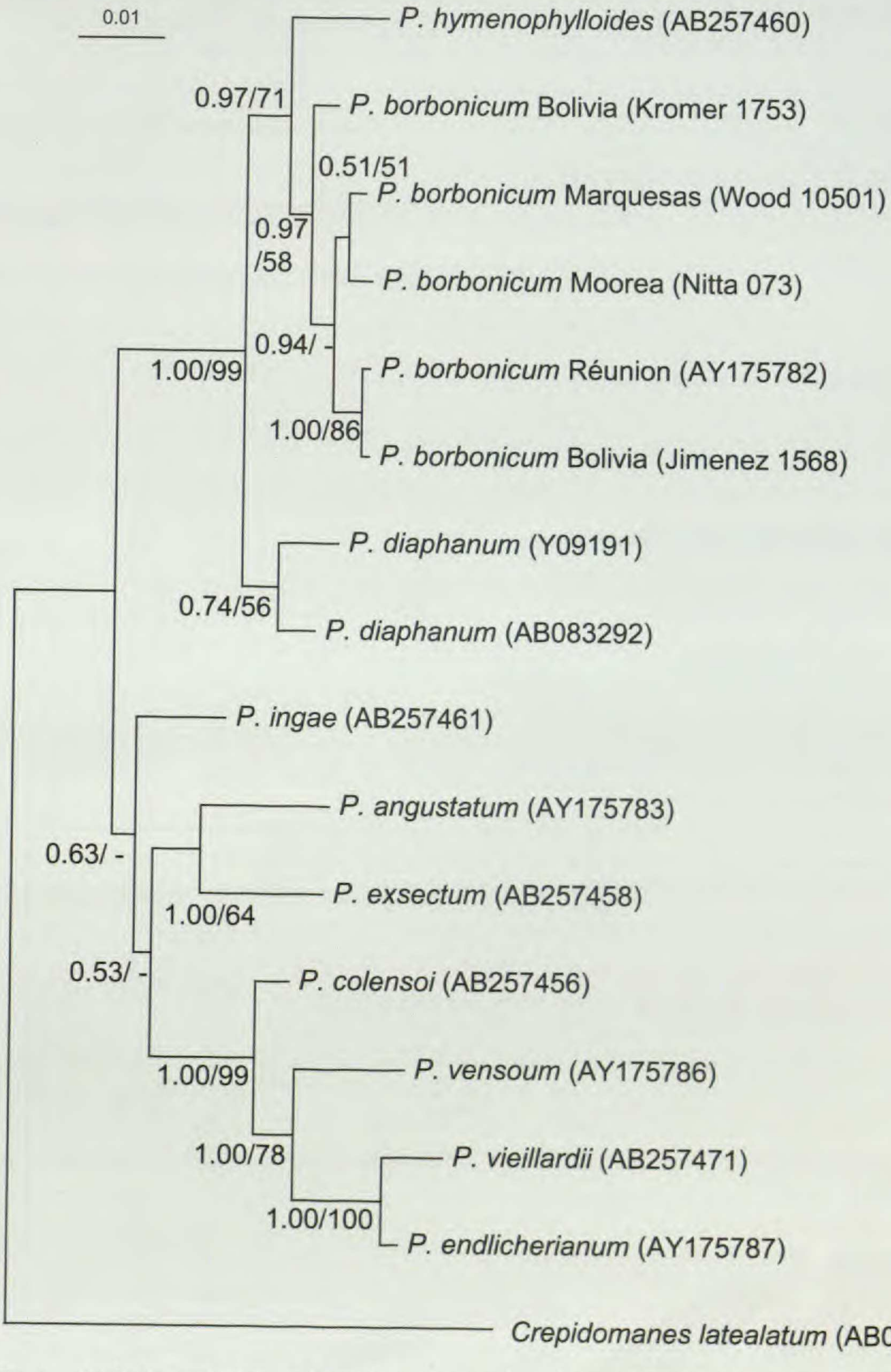

FIG. 3. A phylogenetic tree of Bayesian inference based on 1077bp of chloroplast *rbcL* sequences. Numbers at the nodes indicate support values (Bayesian posterior probability/maximum parsimony bootstrap).

TABLE 2. A comparison of morphological characters of *Polyphlebium borbonicum*, *P. diaphanum* and *P. endlicherianum*.

Character	*P. borbonicum*	*P. diaphanum*	*P. endlicherianum*
Marginal elongate cells	Absent	Absent	Present
Width of ultimate segments	0.8–1.0 mm	0.4–0.8(–1.0) mm	0.5–1.0 mm
Wings of rachis	Flat	More or less waved	Flat

TAXONOMIC TREATMENT

Polyphlebium borbonicum (Bosch) Ebihara & Dubuisson, Blumea 51: 240, 2006. *Trichomanes borbonicum* Bosch, Ned. Kruidk. Arch. 5(2): 158, 1861. *Vandenboschia borbonica* (Bosch) G.Kunkel, Nova Hedwigia 6: 213, 1963.

TYPE.—Ins. Borboniae, Boivin 908 (holotype: L? not seen; isotype: B). Fig. 2 a–c

Trichomanes debile Bosch, Ned. Kruidk. Arch. 5(2): 154, 1861.

TYPE.—VENEZUELA. Prov. de Carabado, 700 m, May 1846, Funck & Schlim 596 (holotype: L? not seen; isotype: UC).

Rhizomes long-creeping, frequently branching, filiform, less than 0.5 mm in diameter, densely covered with brown hairs, roots few and fine. Stipes (0.8–) 2–6 cm long, at a distance from the adjacent ones. Blades bipinnatifid-

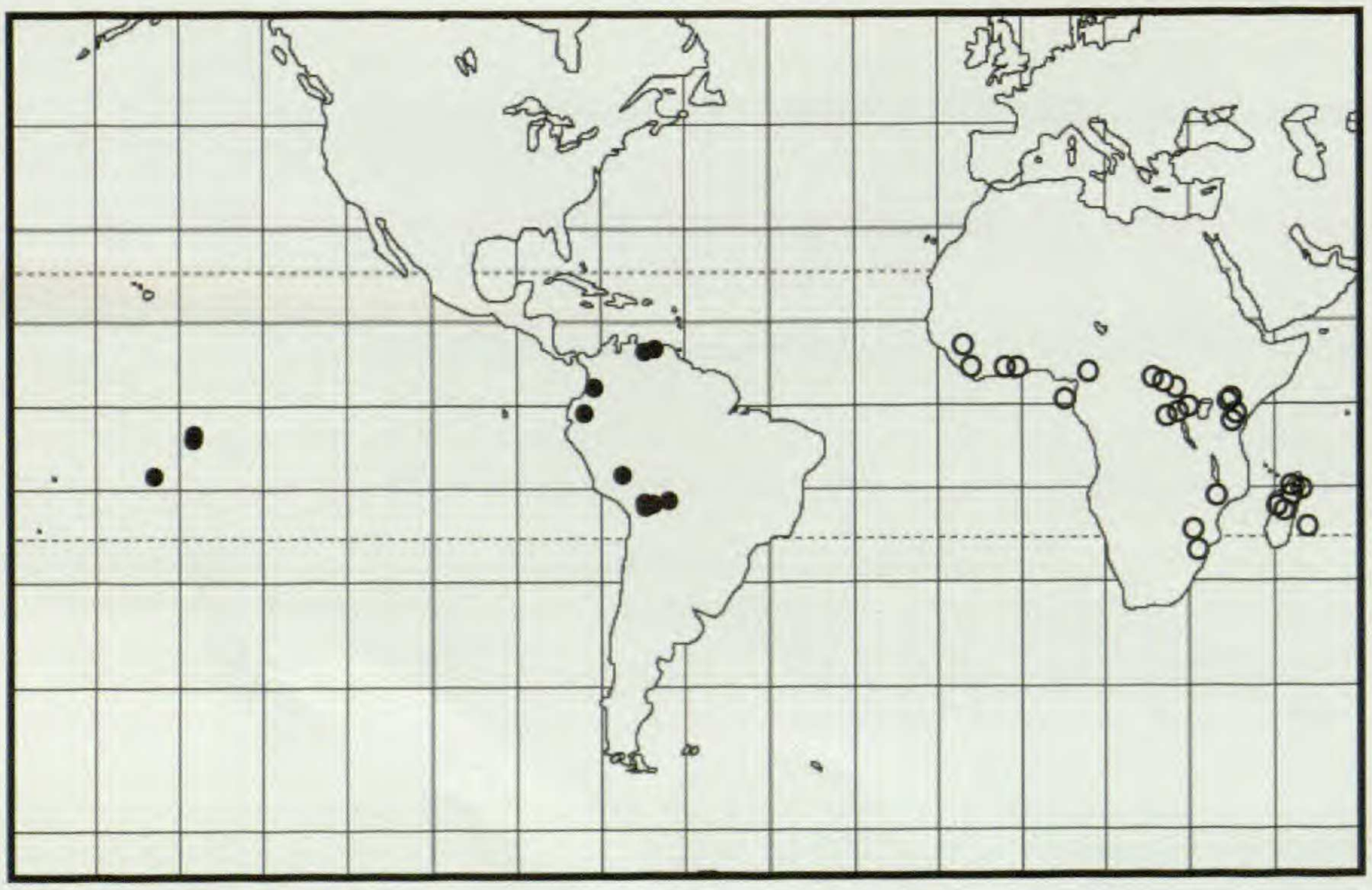

FIG. 4. A distribution map of *Polyphlebium borbonicum*. Black circles: new distributions by present study. White circles: previous records (Tardieu-Blot 1951, Kornaś 1994, Beentje, 2008).

bipinnate, ovate to lanceolate, to 18 cm long and 5.5 cm wide, ultimate segments 0.8–1.0 mm wide, venation anadromous, elongate marginal cells absent, false veinlets absent, internal cell walls thin and straight. Sori paratactic, tubular, lips dilate, receptacle exserted.

DISTRIBUTION.—Mascarene Islands, Madagascar, Continental Africa, Costa Rica, Colombia, Venezuela, Ecuador, Peru, Bolivia, Marquesas Islands, Society Islands (Moorea) (Fig. 4).

SPECIMENS EXAMINED.—VENEZUELA. Estado Carabado, Limite Distrito Bejuma Distrito Montalbán, 950–1100 m, 26 Dec. 2001, *W. Meier 8775* (UC 1779409). Estado Miranda, Distrito Urdaneta, Cordilera de la Costa, 500–1000 m, 20 Mar. 2004, *W. Meier et al. 10391* (UC 1796788). COLOMBIA. Dept. de Nariño, Ricaurte, osque nublado de montaña, cerca del Sendero Natural, 1800 m, 24 Jun. 1995, *P. S. Baracaldo 050* (UC 1606850). Santa María, 1898–1901, *H. H. Smith 2256* (UC 219628). ECUADOR. *Pichincha, L. Sodiro s.n.* (UC 478203). PERU. Dept. Cuzco, Prov. Urubamba, Ruinas Machu Picchu, base of Huayna Picchu, ca. 2500 m, 3 Jan. 1963, *H. H. & C. M. Iltis 1065* (UC 1348750). BOLIVIA. Dept. Cochabamba, Prov. Chapare, 910 m, 6 Sept. 1996, *M. Kessler et al. 8194* (UC 1617032). Dept. Cochabamba, Prov. Ayopaya, Comunidad Grande, sendero a incacasani Grande, 2430 m, 13 Sept. 2002, *I. Jimenez & A. Moguel 1568* (UC 1780573). Dept. Cochabamba, Prov. Carrasco, Parque Nacional Carrasco, 560 m, 23 Sept. 1997, *A. Acebey 777* (UC 1736913). Dept. La Paz, Prov. Nor Yungas, 5 km de Chuspipata hacia Coroico, 2750 m, 18 Sept. 1997, *M. Kessler et al. 12037* (UC 1620790). Dept. La Paz, Prov. Nor Yungas, Canton Pacdlo a 600 m de la Estacion Biologica Tunquini, 1690 m, 22 Aug. 1998, *A. Portugal et al. 204* (UC 1735646). Dept. La Paz, Prov. Sud Yungas, Alto Beni, Territorio Moseten, parcela V PIAF, 1150 m, 6 Apr. 1999, *T. Kromer 1753* (UC 1749657). Dept. La Paz, Prov. J. Bautista Saavedra M., Pauji-Yuyo, entre Apolo y Charasani, 1450 m, 7 Jun. 1997, *M. Kessler et al. 9860* (UC 1622866). MARQUESAS ISLANDS. Nuku Hiva, Toovii, Ooumu area, top of Tapueahu Valley off new Hwy, 3500–3700 ft, 24–26 Sept. 1995, *K. R. Wood & S. Perlman 4640* (PTBG 24438). Ua Huka, Vaikivi summit region and drainage, 700 m, 16 Jun. 2004, *K. R. Wood 10749* (BISH, P, PAP, PTBG 36576, UC 1797858, US); Hitikau region, via Matukuoha Ridge overlooking Hane, 750 m, 5 Dec. 2003, *K. R. Wood 10539* (BISH, P, PAP, PTBG, US). Ua Pou, Anakooma River valley ESE of Oave peak, 380 m, 17 Jul. 2003, *D. H. Lorence et al. 9110* (P, PAP, PTBG, US); Pou Maka, ridge from SE base of peak heading toward Teavahaakiti, 690 m, 19 Jun. 2004, *D. H. Lorence 9336* (PTBG 41942, UC 1797870); Tekohepu, 2500–300 ft, 4–5 Jul. 1997, *K. R. Wood & S. Perlman 6450* (PTBG 24434). Hiva Oa, Temetiu, 3200 ft, 24 Aug. 1995, *K. R. Wood 4406* (PTBG 24440). Fatu Hiva, Trail from Omoa along Punaitai ridge crest to base of Tekou peak, 550–840 m, 23 Jul. 1988, *D. H. Lorence et al. 6179* (PTBG 6271). SOCIETY ISLANDS. Moorea, Mt. Moaputa. Trail from Vaiare to summit, ca. 700 m, 11 Nov. 2006, *J. H. Nitta 73* (UC 1876625).

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LITERATURE CITED

BEENTJE, H. 2008. Hymenophyllaceae. In Flora of Tropical East Africa. Royal Botanic Gardens, Kew.

EBIHARA, A., J.-Y. DUBUISSON, K. IWATSUKI, S. HENNEQUIN and M. ITO. 2006. A taxonomic Revision of Hymenophyllaceae. Blumea 51:221–280.

EBIHARA, A., H. ISHIKAWA, S. MATSUMOTO, S.-J. LIN, K. IWATSUKI, M. TAKAMIYA, Y. WATANO and M. ITO. 2005. Nuclear DNA, chloroplast DNA, and ploidy analysis clarified biological complexity of the *Vandenboschia radicans* complex (Hymenophyllaceae) in Japan and adjacent areas. Amer. J. Bot. 92:1535–1547.

EBIHARA, A., K. IWATSUKI, M. ITO, S. HENNEQUIN and J.-Y. DUBUISSON. 2007. A global molecular phylogeny of the fern genus *Trichomanes* (Hymenophyllaceae) with special reference to stem anatomy. Bot. J. Linn. Soc. 155:1–27.

KORNAŚ, J. 1994. Filmy ferns (Hymenophyllaceae) of Central Africa (Zaire, Rwanda, Burundi). 2. *Trichomanes* (excl. subgen. *Microgonium*). Fragm. Florist. Geobot. 39:33–75.

LELLINGER, D. B. 1989. The Ferns and Fern-allies of Costa Rica, Panama, and the Chocó (Part 1: Psilotaceae through Dicksoniaceae). Pteridologia 2A:1–364.

NITTA, J. H. 2008. Exploring the utility of three plastid loci for biocoding the filmy ferns (Hymenophyllaceae) of Moorea. Taxon 57:725–736.

TARDIEU-BLOT, M. L. 1951. 3e Famille, Hyménophyllacées. In Flore de Madagascar et des Comores (Plantes vasculaires), Edited by H. Humbert. Paris, Museum National d'Histoire Naturelle.